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TECHNICAL
PAPER
NUMBER 16

SILVICAL CHARACTERISTICS OF CALIFORNIA RED FIR AND SHASTA RED FIR

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GEORGE M. JEMISON, DIRECTOR
BERKELEY - APRIL 1957

FOREST SERVICE - U. S. DEPARTMENT OF AGRICULTURE

Preface

The Forest Service is engaged in assembling information on the silvical characteristics of important forest trees of the United States. Much material that is of value in silviculture and research is widely scattered and difficult to locate. This report presents, in preliminary form, the information that has been collected for one species of tree. Similar reports are being prepared for other species at the California Forest and Range Experiment Station and at other forest experiment stations. Readers are encouraged to notify the authors of omissions, errors, or new information affecting the silvical characteristics of the species.

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By William E. Hallin
Division of Forest Management Research

Technical Paper No. 16 April 1957

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE

The Experiment Station is maintained at Berkeley, California in cooperation with the University of California.

Agriculture--Forest Service, Berkeley, California

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California red fir (Abies magnifica A. Murr.) and Shasta red fir (Abies magnifica var. shastensis Lemm.) are believed to be almost identical in silvical characteristics. The only known morphological differences are those in the cone structure by which the typical species and variety are distinguished. Their range extends from the Cascade Mountains in southwestern Oregon south to the North Coast Ranges of California and through the Sierra Nevada to central California and western Nevada (fig. 1). In the more northern parts of their range, especially in southern Oregon, the variety is more prevalent than the type species; southward the Shasta variety is less abundant. In this report no distinction will be made between them and they will be referred to collectively as red fir.

Red fir extends from latitude 43° 35' N. in the southern Cascades in Oregon down the coast ranges to Lake County in California and down the Sierra Nevada to the Kern River drainage, latitude 35° 40' N. It also is indigenous to Washoe County in western Nevada (10).

Although logging started only recently in red fir, the tree is destined to become of substantial economic importance. It produces wood of good quality, and the tops of red fir saplings bring premium prices as Christmas trees in the California markets. Its growth behavior and requirements are less well known than those of trees that have been commercially important for a long time, and experimental work is just getting underway in southern Oregon and northern California.

HABITAT CONDITIONS

CLIMATIC

Red fir grows in a habitat characterized by long winters with a heavy snowpack and short, dry summers. Where it is the predominant tree, the snowpack usually remains until late June or early July. Precipitation--about 80 percent snow--varies from 30 to 60 inches. The annual precipitation on areas with optimum development of red fir averages 40 to 50 inches. July and August precipitation is commonly less than 1 inch--usually from thundershowers and very spotty in character.

Maximum temperatures seldom exceed 80° F. and very rarely exceed 90° F. Minimum temperature may be -25° F. or lower.

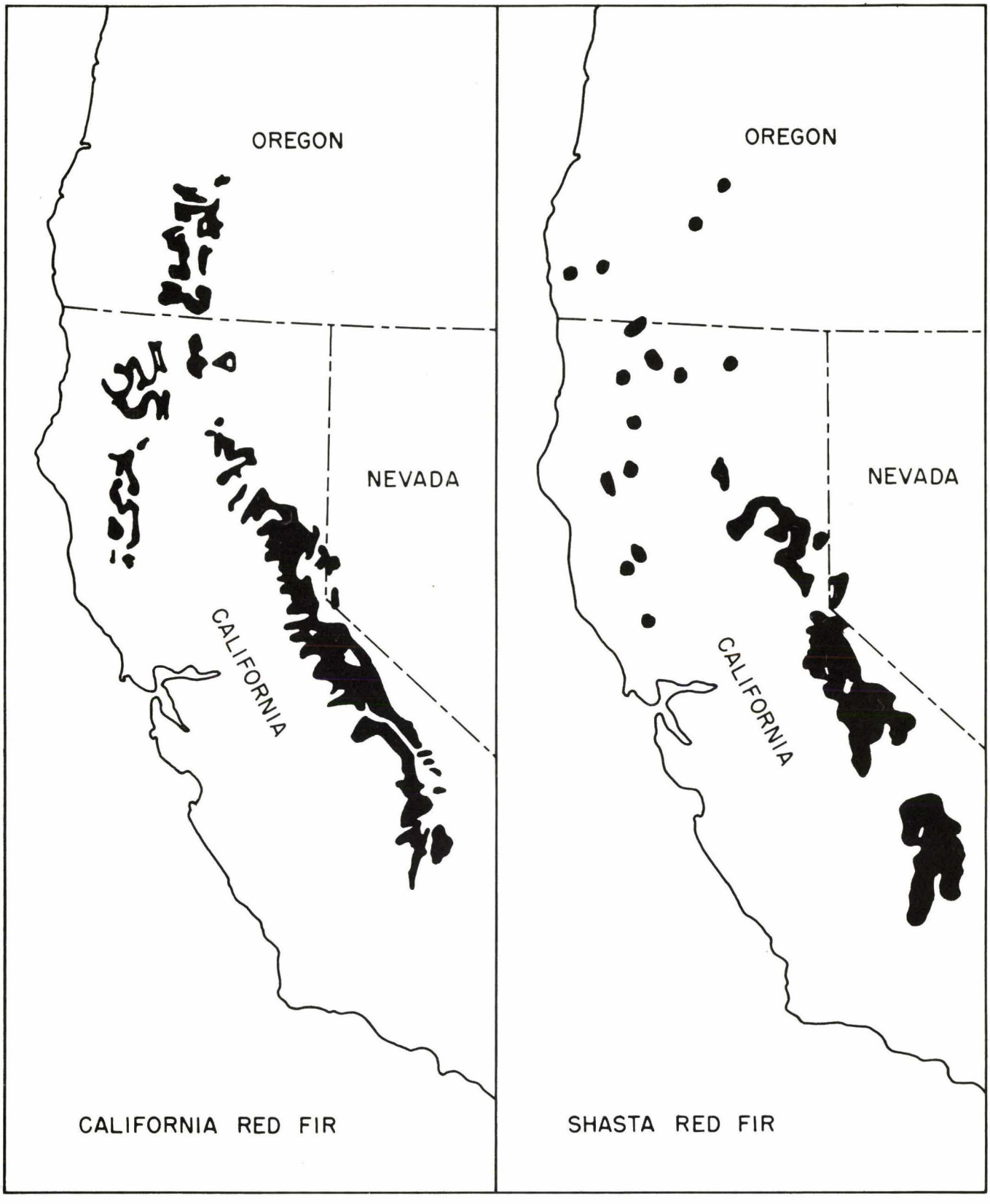

Figure 1.--The natural range of California red fir and Shasta red fir. (From Munns, E. N. 1938. The distribution of important forest trees of the United States. U. S. Dept. Agr. Misc. Pub. 287, 176 pp.)

Red fir forests occur in the Canadian life zone. Individual trees also are found in the Transition and Hudsonian zones.

EDAPHIC

Red fir grows on soils derived from a variety of parent materials. In the Sierra Nevada of California, its best development apparently is on glacial moraines or on unglaciated areas with a deep soil (5). Well drained soils on gentle slopes are particularly favorable. It is also found on protected steep slopes and on level areas where water from melting snow does not stand. On windswept slopes and shallow, rocky soils the trees are small and unthrifty. In southern Oregon red fir is commonly found on clay loams and pumice soil.

At 5 locations in the central Sierra Nevada within red fir stands, the soil pH varied from 5.0 to 6.1 in the surface inorganic layer and 4.6 to 6.0 in the organic layer (5). The loss on ignition at these 5 stations varied from 6.8 to 19.4 percent in the inorganic surface mineral soil and from 64.9 to 81.8 percent in the organic layer. This sharp contrast indicates a mor humus type of soil. However the dry summers prevent development of a true mor humus and accompanying podzol.

PHYSIOGRPHIC

Red fir occurs chiefly between elevations of 6,000 and 9,000 feet over its range. However, on the west slopes of the Cascades in southern Oregon and in northern California it occasionally is found at 5,000 feet and infrequently at 4,500 feet.

Pure stands typically occur at relatively high altitudes within a narrow belt of about 1,000 feet difference in elevation.

BIOTIC

Red fir is most prevalent in its central altitudinal zone, either in pure stands or in mixture with white fir (Abies concolor (Gord. and Glend.) Lindl.). In these mixed stands the proportion of red fir increases with altitude. In the northern part of its range it also grows in mixture with noble fir (Abies procera Rehd.). At its upper altitudinal range it appears with lodgepole pine (Pinus contorta Dougl.), western white pine (P. monticola Dougl.), whitebark pine (P. albicaulis Engelm.), and mountain hemlock (Tsuga mertensiana (Bong.) Carr). At its lower elevation it mixes with sugar pine (P. lambertiana Dougl.), Jeffrey pine (P. jeffreyi (Grev. and Balf.), ponderosa pine (P. ponderosa Laws.), lodgepole pine, incense-cedar (Libocedrus decurrens Torr.), white fir, and Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco).

In its zone of optimum development red fir stands often are very dense. Fully stocked stands are even-aged and crown closure is complete. Few herbs, shrubs, or young trees are present. In many places the ground is completely bare and has a surprisingly shallow duff layer above the mineral soil. Duff layers up to 2 inches thick have been reported.

Where openings have been created by insects, disease, wind, or fire, and where restocking with trees is not yet complete, a variety of herbs and shrubs will be found. They may include any of the common plants of the Canadian, Transition, and Hudsonian zones, such as: pine-mat manzanita (Arctostaphylos nevadensis Gray), bitter cherry (Prunus emarginata Dougl.), sticky current (Ribes viscosissimum Pursh.), round leaf snowberry (Symphoricarpos rotundifolia Gray), whitethorn (Ceanothus cordulatus Kell.), and bush chinkapin (Castanopsis sempervirens Dudley).

Large brush fields may reseed to trees very slowly, but the evidence is that red fir eventually will reclaim them.

Red fir is rated as intermediate in tolerance when compared with other conifers (2). It commonly will recapture the ground occupied by intermingled patches of lodgepole pine. Many examples of various stages of conversion from lodgepole to red fir--red fir seedlings, saplings, and poles in lodgepole stands and young red fir stands containing lodgepole windfalls--can be seen on the Swain Mountain Experimental Forest.

Virgin red fir forest is regarded by Oosting as a true climatic climax plant association (5).

LIFE HISTORY

SEEDING HABITS

Pollination is believed to occur in June, cones ripen in August, and seed is dispersed in September and October.

Good seed crops appear at 2- or 3-year intervals. For example, on a clear-cut area in southern Oregon, the Pacific Northwest Forest and Range Experiment Station recorded nearly 140,000 red fir seeds per acre fell in 1951 (8), and 164,000 in 1953.

Insects at times severely reduce the quantity of good seed produced.

Red fir seeds are disseminated primarily by wind. They fall at the rate of 5.3 feet per second (7). A 10-mile-per-hour wind would carry seed 405 feet from a height of 150 feet.

VEGETATIVE REPRODUCTION

Red fir does not reproduce naturally by sprouting from the root collar or by rooting (layering). Like many other conifers, red fir saplings when topped for Christmas trees will generally send up a new top from a bud on the stem or branch below. Limbs in the whorl of branches just below the cut will sometimes turn up and form a new top, particularly on open-grown thrifty trees.

SEEDLING DEVELOPMENT

Red fir seeds have medium to low viability. In a clear-cut area in southern Oregon only 2.2 percent of the natural seedfall germinated in 1952, and 3.7 percent of the natural seedfall germinated in 1954, according to the Pacific Northwest Forest and Range Experiment Station. Rodent depredations may have affected the results of this test. Despite the low germination, this area had a total of 3,800 red fir seedlings per acre, and 59 percent of the mil-acres were stocked in the fall of 1955. The red fir seedlings were hardy and survival during the first few years was good. Red fir seedlings may become established either in clearings or partially cut areas. Red fir seeds frequently germinate in the snow above the ground.

Seedling losses are commonly caused by insects, drouth, and gophers (8). The seedlings appear to be intermediate in frost resistance between white fir and sugar pine (6). Some frost injury to new growth on seedlings in clearings has been observed, but development was not severely retarded.

Red fir commonly restocks small openings created by fire, cutting, or other causes. Even-aged stands of saplings and poles from 1 or 2 acres to 15 to 20 acres in size are common in the red fir type in northeastern California. The Pacific Northwest Forest and Range Experiment Station reports that in a sample of 10 clear-cut patches 8 to 35 acres in size in the red fir type in southern Oregon, 6 were well stocked, 2 medium stocked, and 2 poorly stocked 2 to 5 years after logging.

Red fir grows very slowly during the seedling and sapling stages--much more slowly than Jeffrey pine, for example. Under natural conditions in openings in the forest, average seedlings are likely to require 5 to 10 years to attain a height of 1 foot. Until they reach about 12 to 15 feet in height, terminal shoots generally grow only 2 to 6 inches each year under typical wild stand conditions. This may be an adaptation to the exceedingly deep snowpack which covers them each winter until they attain heights of 10 to 20 feet. In partial shade, height growth is equally slow or slower.

Precise information regarding optimum size of openings for establishment and growth of red fir seedlings is not available. However, the openings must be small enough to permit adequate seed dispersal and large enough to permit satisfactory growth without excessive competition from border trees.

SAPLING STAGE TO MATURITY

Red fir commonly grows in dense stands until maturity. A 4-acre sample of a mature stand (age 200 years) on the Swain Mountain Experimental Forest in Lassen County, California, had a gross volume of 140,000 board-feet per acre, with an average of 90 trees 12 inches and larger d.b.h. per acre. The largest tree on record is 100 inches d.b.h. and 177 feet tall (1). A tree 66 inches d.b.h. and 186 feet tall was measured on the Swain Mountain Experimental Forest. Considerably taller trees may have gone unreported or may still be discovered.

Heart rots which enter through scars--especially basal fire scars--cause extensive losses in mature stands (4). Cull in mature stands commonly ranges from 30 to 50 percent of the gross volume. The common heart rots are yellow cap fungus (Pholiota adiposa Fr.), fomes butt rot (Fomes annosus (Fr.) Cke.), shoestring fungus (Armillaria mellea Vahl.) Quel.), sulfur fungus (Polyporus sulphureus (Bull.) Fr.), and Indian paint fungus (Echinodontium tinctorium E. and E.).

Dwarfmistletoe (Arceuthobium campylopodum Engelm. f. abietinum Gill) causes extensive damage in stands from sapling size through maturity (3). Dwarfmistletoe is rarely found on trees under 3 or 4 feet in height. Dwarfmistletoe either directly or indirectly causes mortality, and it also leads to much damage by lowering the vigor of trees, deforming them, serving as entrance courts for decay organisms, and weakening the trunk at bole cankers.

Insects frequently cause serious mortality. The common tree-killing insects are the fir engraver (Scolytus ventralis Lec.) (9), the flatheaded fir borer (Melanophila drummondi (Kby.)), and the roundheaded fir borer (Tetropium abietis Fall).

Saplings and small poles frequently are broken or deformed by the crushing action of deep snow. Once the young trees have emerged above the level of the deepest snow, much less snow injury occurs because the stem and branches are exceptionally well adapted to resisting it. Sweep in butt logs of mature trees is common as a result of the trees being bent by snow movement while they were young.

Windthrow losses are commonly very severe after selection cutting in mature stands. However, if selection cuts are light, windthrow losses may be low. The intensity of selection cutting which can be made without incurring excessive windthrow has not been determined.

Even-aged management by clear cutting is recommended because of windthrow losses following selection cutting, heart rot entrance through logging scars, prevalence of dwarfmistletoe in mature stands, and slow growth rate of understory trees. The predominantly even-aged character of wild stands seems further to indicate that attempts at uneven-aged management would violate natural principles.

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